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APPRAISAL OF SOME MEDICINAL AND OTHER USES OF CHILLI PEPPER (*CAPSICUM FRUTESCENS* LINN.)

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ABSTRACTS

Chili (*Capsicum frutescens* Linnaeus) is known for its pungency, color and flavor. Both green and red chilies are serves as spice in every cuisine in preparing different palatable items in the world. The plethoric of its nutritional, medicinal quality and benefits attributed to its rich phytochemical constituents derived from capsaicin (capsaicinoid) bioactive plant. Chili contains quality amount of vitamin A and other vitamins such as vitamin C, vitamin B6, and minerals like calcium, folate, thiamin, etc. Many recent researches on Chili pepper have shown its chemical constituent which include, Capsaicin, Dihydrocapsaicin, Homocapsaicin, Homodihdrocapsaicin, Nvanillyldecanamide, Nordihydrocapsaicin etc, these constituents are the active ingredients that account for the rich medicinal phytochemistry of Chili pepper. Capsaicin has multifarious uses in pharmaceutical industry that are ascribed to the relief of pain, anti-arthritic, anti-bacterial, anti-inflammatory, anti-rhinitis, and analgesic properties. It has an outstanding role as an immunity booster for the management of cardiovascular diseases, type-2 diabetes, obesity and stops the spread of prostate cancer. Numerous studies based on phytochemical analysis and clinical trials have proved that the constituents of Chili pepper show significant effect in the prevention and treatment of diseases via modulation of genetic and metabolic activities hence its medicinal and nutritional roles. In addition to its active compounds like Capsanthin, Capsaicin, Violaxanthin, Lutein, sinapic acid, it is also use as a defense weapon and animal Repellent for farmer's and residents. The consumption

of chili is reported to be related with reduced peril in human being. Therefore, chili should be include as essential daily diet in meals.

KEYWORDS: Capsaicinoid; Capsaicin; Chilli peppe; Medicinal benefit; Nutritional benefits.

INTRODUCTION

Chili Pepper (*Capsicum frutescens* Linn.) is a bioactive plant that is known for its pungency with a chemical content known as capsaicin and dihydrocapsaicin derived from capsaicinoid, an alkaloid that is extracted from chili pepper an important commercial crop that is grown all over the world. It is a dicotyledonous flowering plant and belongs to the genus *Capsicum* which is a member of the *Solanaceae* family.[1] With different names such as tabasco pepper, chile pepper and cayenne pepper, jalapeno etc. having plethora nutritional and medicinal value. *Capsicum* has been known as part of the human diet as spice, condiments and vegetables for ages.[2] Green fruits of chili are usually serve as vegetable and the ripe dried fruits as chilli flakes, spice because of its pungency and imposing flavor. It is widely used in Bangladesh, West Africa like Nigeria, Ghana due to its pungent nature, colorful and igneous flavor that brought about its daily demand.[3] Many cultivars are grown in Bangladesh, india, china, Nigeria with average production of 1 -1.2million tones with different in habit, size, shape, color, yield, pungency of the fruit and preference demands.

Chili is mainly for seasoning and as medicinal plant, but today its uses extended to fresh and processed vegetable, spice, dried forms, used as food dye, bred as ornamental plant and production of extracts for various pharmaceutical and cosmetics industry.

CHILI PEPPER AS FUNCTIONAL CROP

The constituents derived from chilli pepper serves as a functional crop which contained important nutritional substances and play a vital functions in the body by minimizing risk of certain diseases and improve health condition. A functional crop must clarify its potential with exact quantity to be present in a diet. The presence of capsaicin and other known active principles in chili, can be regarded as a functional crop. The consumption of hot red chili pepper reported to be associated with reduced mortality. Hot red chili peppers may be a beneficial component of the diet.[4]

The Chemistry of Chili pepper

The capsaicinoids ($C_{18}H_{27}NO_3$) are derived from capsaicin and dihydrocapsaicin, the predominate among the seven capsaicinoids .Capsaicin an alkaloid present in the placenta of the fruit, which can directly reduce various free radicals in chili peppers that brings about the pungent nature, is used as an analgesic in topical ointments, nasal sprays, and dermal patches to relieve pain. *Capsicum* Fruit has a unique pungent features that are derived from an alkaloid which is probably the most important flavor trait of peppers. The rest five compounds (norcapsaicin, nordihydrocapsaicin, nornordihydrocapsaicin, homocapsaicin and homodihydrocapsaicin), are considered minor capsaicinoids. Capsaicin and its related compounds are the active ingredients in pepper that are related to the anti-microbial and anti-carcinogenic and other medicinal properties in pepper. The pungency of pepper are being measured using Scoville organoleptic method and High Performance Liquid Chromatography (HPLC). Environmental factors and genetic makeup determines the level of pungency in pepper. Among the cultivated peppers *C.annuum* is the most variable in pungency and both *C.chinense* and *C.frutescens* are the highest and *C.baccatum* the lowest while *C.pubescens* is mild.[1] The applications of capsaicinoids in pharmaceutical industry are attributed to its antioxidant, anticancer, antiarthritic and analgesic properties.[5]

MEDICINAL BENEFIT AND OTHER USES OF CHILLI PEPPER

Anti-inflammatory

The phenolic compound in chili pepper (8-methyl-N-vanillyl-6-nonenamide) is a potent inhibitor of substance P (prostaglandin), a neuropeptide associated with inflammatory processes.[6] It stimulates the blood flow to the site by reducing inflammation and inhibit the effects of cycloxygenase (COX) by reducing production of prostaglandin. The phenolic compound (Capsaicin) effects the treatment of the sensory nerve fiber disorders, including pain associated with arthritis, psoriasis, and diabetic neuropathy. When animals injected with a substance that causes inflammatory arthritis, animal like rats were fed a diet that contained capsaicin, they had delayed onset of arthritis and also reduced paw inflammation. *Capsicum frutescens* has potential antioxidant and anti-inflammatory compounds which could be used as epitome in medicinal chemistry.[7]

Fig 1: Arthritis pain relief cream.

Natural Pain Relief

Following the transient receptor potential vanilloid 1 (TRPV1) receptor, capsaicin exerts its effects through the vanilloid receptor subtype 1 (TRPV1), which is also stimulated by heat, proton and physical abrasion. when activated by ligand-binding, TRPV1 allows cation influx, resulting in membrane depolarization, which relays pain information to the brain without any direct tissue damage this mechanism causes desensitization to nociceptive stimuli by decreasing impulse propagation in these neurons thereby relieving pains.[8] The degree of pain relief from topical capsaicin is below the level considered clinically important for the treatment of chronic pain as stated by American Academy of Neurology clinical practice guideline.[9] Both 0.025% and 0.075% of capsaicin cream was effective when it is applied topically in the relieve of post herpetic neuralgia. Proves of pain relieve from other causes, like trigeminal and diabetic neuralgia, osteoarthritis, postsurgical neuralgias[10] and vulvar vestibulitis has been documented by researchers.[11]

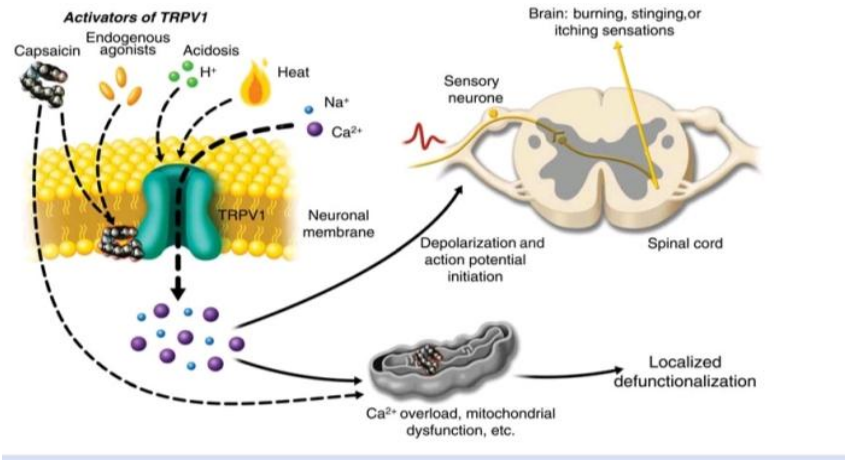

Fig 2: Mechanism of TRPVI in pain relief.

Prevents Sinusitis and Relieves Congestion (Anti-rhinitis Agent)

One of the ingredient of nasal sprays is found in anti-rhinitis agent that contain capsaicin and very effective in sinus problem like allergic rhinitis.[12] It clear mucus from the nose by taking off nasal congestion. It also has antibacterial properties that can fight against chronic sinus infections. It opens sinus passage releasing allergens from the nose by anti-inflammatory activity. Green chili aids in increasing the nasal secretion and also provides relief from rhinitis.

Aromatherapy and Cosmetic Applications(Chilli seed oil)

Chili seed essential oil also known as *Capsicum oleoresin* is one of the aromatherapy and cosmetic applications ingredients used in Spa, personal care formulations, soaps, perfumery, incense, candles.

It is derived from the steam distillation of hot pepper seeds which is semi viscous dark orange or red color oil which can be use as cooking oil with less cholesterol.

Fig 3: Chili seed essential oil.

Boost Immunity

β-carotene a pro-vitamin A are highly seen in Red chili peppers of bright color and vitamin C in green chili which strengthen the immune system of the body. The anti-infection vitamin (vitamin A) is essential for healthy mucous membranes, which line the nasal passages, lungs, intestinal tract and urinary tract and serve as the body's first line of defense against invading pathogens. Capsaicin a bioactive content in chili are serve as immune boostal against diseases in the body.[13]

Cardiovascular Benefits

Calcitonin gene-related peptide(CGRP) is considered to be one of the most powerful vasodilators and plays an important role in regulating blood pressure under both physiological condition and pathophysiological condition when is been released by the stimulation of capsaicin therefore decreases blood pressure. Cayenne (Red chili) have ability to reduce blood cholesterol, tri-glyceride levels, and platelet aggregation, while increasing the ability of body to dissolve fibrin, a substance integral to the formation of blood clots. The cardiovascular system is rich in capsaicin-sensitive sensory nerves that plays a major role in regulating cardiovascular function through the release of neurotransmitters such as Calcitonin

gene-related peptide(CGRP).[13] Findings states that spicing meals with chili peppers may also prevent the deposition of fats in blood vessel walls caused by free radicals – a first step in the development of atherosclerosis.[14]

Chili Serves As Weight loss

Obesity is a serious health condition that increases your risk of many chronic illnesses, such as heart disease and diabetes. Some evidence suggests that capsaicin can promote weight loss by reducing appetite and increasing fat burning.

In fact, studies show that 10 grams of red chili pepper can significantly increase fat burning in both men and women .Capsaicin may also reduce calorie intake. A study in 24 people who consume chili regularly discovered that taking capsaicin before a meal led to reduced calorie intake.[15]

Another study observed a significant reduction in appetite and calorie intake only in those who did not regularly consume chili .Not all studies have found chili peppers to be effective. Other studies saw no significant effects on calorie intake or fat burning. Despite the mixed evidence, it appears that regular consumption of red chili peppers or capsaicin supplements may aid weight loss when combined with other healthy lifestyle strategies.

Prevent the Spread of Prostate Cancer

Capsaicin stimulates the anti-tumorigenic/ tumor-suppressive signaling pathway and related transcription factors, whereas it inhibits oncogenic signaling pathways and tumor promoters. capsaicin interacts with other cancer preventive agents synergistically, providing the possibility for the potential use of capsaicin in cancer therapy with other chemotherapeutic agents through targeting multiple signaling pathways and cancer associated genes in different tumor stages of activation of apoptosis, cell growth arrest, inhibition of angiogenesis and metastasis. In addition, Capsaicin lessen the expression of prostate-specific antigen (PSA), inhibits the ability of the most potent form of testosterone, dihydrotestosterone, to triggers PSA, and directly inhibits PSA transcription, causing PSA levels to drop sharply.[16]

Lower Risk of Type 2 Diabetes and Obesity

Analysis of the related genes suggested that the transient receptor potential vanilloid 1 (TRPV1) receptor was activated by capsaicin which helps during glucose homeostasis and improve visceral fat remodeling through connexin-43-mediated Ca^{2+} influx, thereby

stimulating the GLP-1(glucagon-like peptide1 is an incretin hormone that induces expansion of insulin secretion β-cell mass) secretion from incretin tumor cells. Overfeeding (high –fat diets) have been proposed to decrease muscle glucose uptake and increase hepatic gluconeogenesis, both conditions resulting as an outcome of insulin resistance. insulin resistance in liver and skeletal muscle leads to hyperglycemia, hyperinsulinemia then dyslipidemia and fatty liver. Capsaicin stimulate the insulin receptor substrate 1(IRS-1) to enable blood glucose passes to body cells where it is used as energy. Epidemiological data revealed that the consumption of foods containing capsaicin was associated with a lower prevalence of obesity. In another randomized double-blind study, it indicated that subjects between 30 and 65 years old with a BMI> 23kg/m2 treated with capsaicin (10mg/kg per day) for 4weeks safely and body weight tended to decrease durig the 2 to 4 weeks period to lower blood sugar levels after a meal, but chili-containing meals also result in a lower.[17] Chilies also contain antioxidants, including vitamin C and carotenoids, which might help to improve insulin regulation.[14]

Prevent Stomach Ulcers(prevent the infection of the stomach with *Helicobacter pylori)*

Capsaicin aids in preventing the infection of the stomach with *Helicobacter pylori* which has been found to be the main cause of gastric ulcers and inhibits acid secretion. It stimulates alkali, mucus secretions and particularly gastric mucosal blood flow which help in prevention and healing of ulcers. Capsaicin acts by stimulating afferent neurons in the stomach and signals for protection against injury causing agents.[18]

Other uses Of Chili Pepper

Chili Grenade as a weapon for defense

A chili grenade is a type of non-lethal weapon developed by Indian military scientists at the Defence Research and Development Organisation for use by the Indian Armed Forces. The weapon is similar to tear gas. Currently "civilian variants" are being used for crowd control in Jammu and Kashmir.

The grenades uses one of the world's spiciest chili pepper, bhut jolokia, species in weaponized form. The weapon emits a powerful skin and eye irritant as well as pungent smell that causes enemies to leave their cover or become physically incapacitated by the grenade's load. The pepper being used is the thumb-sized "bhut jolokia," or "ghost chili," which had previously been recognized by Guinness World Records as the hottest pepper in the world,

but was later superseded by two other pepper cultivars, the Carolina Reaper and the Trinidad moruga scorpion. One bhut jolokia is more than 1,000,000 Scoville units.

Pepper Spray for Self defense

Pepper spray, *oleoresin capsicum* (OC) spray, capsaicin spray, or *capsicum* spray is a lachrymatory agent (a compound that irritates the eyes to cause a burning sensation, pain, and temporary blindness) used in policing, riot control, crowd control, and self-defense, including defense against dogs and bears. Its inflammatory effects cause the eyes to close, temporarily taking away vision. This temporary blindness allows officers to more easily restrain subjects and permits people in danger to use pepper spray in self-defense for an opportunity to escape. It also causes temporary discomfort and burning of the lungs which causes shortness of breath. The active ingredient in pepper spray is capsaicin, which is derived from the fruit of plants in the genus *Capsicum*, including chilis. Extraction of *oleoresin capsicum* (OC) from peppers requires *capsicum* to be finely ground, from which capsaicin is then extracted using an organic solvent such as ethanol. The solvent is then evaporated, and the remaining waxlike resin is the oleoresin capsaicin. An emulsifier such as propylene glycol is used to suspend oleoresin Capsaicin in water, and the suspension is then pressurized to make an aerosol pepper spray.

Personal pepper sprays can range from as low as 0.18% to as high as 3%. Most law enforcement pepper sprays use between 1.3% and 2%. The federal government of the United States has determined that bear attack deterrent sprays must contain at least 1.0% and not more than 2% CRC. Capsaicin and related capsaicinoids does not measure the amount of oleoresin Capsaicin within the formulation. Instead, CRC is the pain-producing component of the Oleoresin Capsaicin that produces the burning sensation.

Fig 4: Chili grenade (pepper ball) and pepper spray.

Chilli Peppers Serves as Animal Repellent

Hot pepper wax animal repellent

Hot Pepper Wax (BONIDE) uses hot cayenne pepper to repel animals from your yard (resident) and farm. Can be used on listed fruits, vegetables, and ornamentals. Animal repellent for fruits, vegetables and ornamentals extracted from hot cayenne pepper, which one application can last up to 4 weeks and can apply on wood structures to prevent animals from chewing the vegetables.

Ready To Use Quart (32oz) Spray Bottle

- PEST REPELLER - Hot Pepper Wax spray effectively repels deer, rabbits, and tree squirrels from eating foliage, stems, buds, fruits, and blooms.
- MULTIPLE USES - Designed for use on fruits, vegetables, citrus, root crops, legumes, indoor/outdoor ornamentals, and grasses. Can also be used to repel animals from chewing wood structures and fences.
- APPLICATION AND TIMING - Apply until foliage or surface is completely wet. Repeat application in 3-7 days for 2-3 weeks, until control is established, as necessary to maintain control.
- READY TO USE - This product is conveniently ready to use when it arrives. The spray nozzle makes this product easy to deploy.

Fig 5: Bonide hot pepper wax animal repellent.

NUTRITIONAL BENEFITS OF CHILLI PEPPER

Both green and red chilies are great source of vitamin C and other antioxidants such as vitamin A, B-complex group of vitamins such as niacin, pyridoxine (vitamin B6), riboflavin and thiamin (vitamin B1) and flavonoids like β-carotene, α-carotene, lutein and zea-xanthin. Chili also carries different minerals like potassium, manganese, iron, and magnesium. Nutritional composition of 100 g peppers in the form of raw green and raw red are shown in Tables 1 to 3.

Nutritional value per 100g of chilli pepper

Table 1: Composition of different vitamins.

Constituents	Green chili pepper	Red chili pepper
Vitamin A	530 IU	428 IU
Retinol	0.0 mcg	0.0 mcg
Retinol activity equiv.	26.5 mcg	21.6 mcg
α-Carotene	10.4 mcg	16.2 mcg
β-Carotene	302 mcg	240 mcg
β-Cryptoxanthin	22.5 mcg	18.0 mcg
Lycopene	0.0 mcg	0.0 mcg
Lutein + Zeaxanthin	326 mcg	319 mcg
Vitamin C	109 mg	64.7 mg
Vitamin E (α-Tocopherol)	0.3 mg	0.3 mg
Vitamin K	64 mcg	63 mcg
Thiamin	0.0 mg	0.0 mg
Riboflavin	0.0 mg	0.0 mg
Niacin	0.4 mg	0.6 mg
Vitamin B6	0.1 mg	0. 2 mg
Folate	10.4 mcg	10.4 mcg
Food folate	10.4 mcg	10.4 mcg
Folic Acid	0.0mcg	0.0 mcg
Dietary folate equiv	10.4 mcg	10.4 mcg
Vitamin B12	0.0 mcg	0.0 mcg
Pantothenic acid	0.0 mg	0.1 mg
Choline	5.0 mg	4.9 mg

Source: Culled from USDA National nutrient Database, (2014).

Table 2: Composition of minerals.

Constituent	Green chili raw	Red chili raw
Calcium	8.1 mg	6.3 mg
Iron	0.5 mg	0.5 mg
Magnesium	11.2mg	10.4 mg
Phosphorus	20.7 mg	19.4 mg
Potassium	153 mg	145 mg
Sodium	3.2mg	4.0 mg

Zinc	0.1mg	0.1 mg
Copper	0.1 mg	0.1 mg
Manganese	0.1 mg	0.1 mg
Selenium	0.1 mcg	0.1 mcg

Source: Culled from USDA National nutrient Database, (2014).

Table 3: Composition of other constituents.

Constituent	Green chili raw	Red chili pepper
Cholesterol	0.0 mg	0.0 mg
Alcohol	0.0 g	0.0 g
Water	39.5 g	39.6 g
Ash	0.3 g	0.4 g
Caffeine	0.0 mg	0.0 mg
Theobromine	0.0 mg	0.0 mg

Source: Culled from USDA National nutrient Database, (2014).

SAFETY, EFFICACY AND TOXICITY OF CHILI PEPPER

Chili and its constituents show many essential therapeutic effects in health management. Measurement of toxicity and lethal dose is important before applying a medicine in health management.

According to[6] several studies were performed to check the safe dose in animal model (rat). The dose and toxicity of capsaicin has been checked and recommended by many researchers.[20] One of these studies stated the dose of 0.0 1g – 6g of capsaicin ingested 2 – 3 times for period of three months to two and half years did not cause any adverse effects.

Another study on animals showed that the dose of 2.5g per kilogram body weight were tolerated without any morbidity and mortality.but when the dose was increased to 3.3 g – 3.5g per kilogram body weight, then there was 10 -30% of mortality.[4] In 2017 review of clinical studies having limited quality found out that high dose topical capsaicin 8% compared with the control 0.4% (capsaicin) provided moderate to substantial pain relief from post herpetic neuralgia, HIV – neuropathy, and diabetic neuropathy.

Report of the Arthritis Research UK found capsaicin effective for treating osteoarthritis and fibromyalgia compared to placebo and can be used safely However, since these experiments used extremely high volume of pepper or concentrations of capsaicin which are extremely far above the normal human consumption, it may be difficult to be considered as risky carcinogenic for humans[21], In addition to that no confirmation on the carcinogenic effect due to capsaicin or other compounds in pepper. Similarly[22] stated that high consumption of

chilies in Mexico and India (25–200mg/day) was reported to be associated with lower cancer of the upper digestive tract.

In contrast, the maximum daily intake from mild chilies and paprika in Europe was roughly estimated to be 1.5mg/day and this low intake of chili had no effect on incidence of gastric cancer. On the other hand the risks could be due to aflatoxin contamination not the capsaicin effect.[23]

Chili may be contraindicated to patients who are hypersensitive to chili or its product. Care should be taken when handling with chilies because it may irritate or burn the eye and skin (irritant, sensitizer)[12], if ingested in large amounts by adults or large amount by children, can produce nausea, vomiting, abdominal pain and burning diarrhea (LD50 in mice is 47.2mg/kg). Excessive consumption of chili maybe toxic as we all know too much of anything can be bad.

CONCLUSION

Chili pepper cultivation is an aged practice as well as the uses in the history, but no much research has been done in those years or evidence of its use as medicinal plant. Medicinal uses and health benefits of pepper are globally well documented. However issues related to safety, efficacy, quality, and development and potential risks, especially those linked to aflatoxin contamination need to be researched. On the other hand farmers should contribute in reducing the aflatoxin contamination at farm level by removing discolored fruits and improving drying method. People all around the world are giving preference to natural products over the synthetic drugs due to their fewer side effects. People have become more health and nutritional conscious in using the natural products for pharmaceutical purposes. Capsaicin has a strong cardiovascular benefits, with almost insignificant side effects. it helps in stimulating the blood flow at a site, reduce cholesterol, makes the ability of the body to dissolve fibrin, a substance integral to the formation of blood clots. This fundamental property of chili pepper can help in fighting numerous diseases of concern. As an immunostimulant, chili possesses biological actions like increasing respiratory burst, transdermal patch activity and relieves pains of the muscle and joints. *Capsicum frutescens* has potent anti- inflammatory properties and thus acts as hepatoprotective agent. It down regulates the inflammatory mediators thereby reducing inflammation and toxicity. Thus, it can widely be used to treat various inflammatory conditions which are the root cause of many disorders. Chili pepper has been reported to be very effective against muscle pain,

osteoarthritis, prostrate cancer, it detoxifies the blood, lowers blood sugars and improve heart disease risk factors by lowering cholesterol levels. Chili seed essential oil is suitable for aromatherapy and also suitable for cosmetic applications. Chilli peppers serve as a defensive weapons like the Chili grenade and pepper spray, also serves as animal repellent for farmers and desert residents. pepper and its constituents have the properties of preventing cancer and tumors. chili pepper also helps to improve brain function and protect against Alzheimer' s disease through its anti- inflammatory activities. Since many effects of chili pepper (*Capasicum frutescens*) have been properly analyzed, there is a future requirement for further studies on the clinical aspect of this natural product.

Nevertheless, all the known metabolic uses of chili pepper may provide novel clues for using this magnificent natural product in therapy so as to break free from the many side effects of synthetic drugs. This will go a long way to guarantee good health and well being of the global population in line with the sustainable development goals.

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